Saskatchewan Agriculture and Food

Caraway in Saskatchewan

Revised: December 2005

Caraway (*Carum carvi*), a member of the Umbelliferae (carrot family), is a biennial spice crop, but an annual type also occurs. It has an erect, branching stem and grows to a height of approximately 0.6 m (2 ft.). Caraway forms a shallow tap root with minimal branching. Flowers form at the terminal buds and are usually white in colour. Caraway seed is used to flavour foods such as bread, cheese, and sauerkraut. The seed contains 2.5 to 4.5 per cent essential oils, used to flavour meats, mouthwash, and liqueurs. Carvone is the principal traded constituent of caraway oil (52 per cent), with limonene making up 45 per cent of the oil. The oil content and composition is influenced by crop maturity, cultivar and growing conditions.

Caraway is cultivated from northern temperate to tropical climates, including northern Europe, Russia, Jamaica, India, Canada, and the United States. Caraway production in Saskatchewan ranged from 4,000–8,000 a (10,000-20,000 ac.) from 1999-2005.

Most commercial production of caraway in Saskatchewan is the biennial type. In the first year, biennial caraway produces a bushy green plant (Figure1). In the second, and sometimes the third year, the plant grows to its full height, produces flowers and sets seed. Plants that have flowered and set seed will die, while plants that have not yet flowered will produce seed the following year.

Figure 1. *Caraway in the four to eight leaf stage.*

Caraway plants with roots of a diameter less than 1.2 cm (½ in.) at the start of the growing season will not likely produce seed that year. They will remain vegetative, increasing in size to produce seed the following year. Caraway plants with a root diameter of approximately 1.2 cm (½ in.) or larger are capable of flowering and producing seed.

Well established caraway plants can be damaged by very cold, (-10 ° C) late, spring frosts. These plants may not bolt and set seed, but remain vegetative for the season.

Yields in Saskatchewan can be variable, ranging from 350-1,100 kg/ha (300-1,000 lb./ac.). The average yield of the biennial caraway in Saskatchewan is 800 kg/ha (700 lbs/acre), whereas, yields of annual caraway are lower.

Annual caraway is very late maturing (120-130 days) for Saskatchewan , and frozen seeds often occur. Annual caraway seed contains approximately 2.5 per cent essential oil, compared to 3.5

per cent in biennial caraway, and thus, is of lower quality. The bushel weight of caraway is 35-40 lb. depending on seed quality.

Adaptation

Figure 2. *Established caraway roots at the start of the growing season. Roots on the left are too small to produce seed in the current year. Roots on the right are capable of producing seed-bearing plants.*

Caraway can be grown successfully over a wide range of soil types and regions in Saskatchewan. Generally, caraway is better adapted to the more moist areas of the province. Sandy soil should be avoided to reduce the risk of poor emergence, and uneven crop stand.

Caraway germinates and develops very slowly, and is a poor weed competitor. Perennial weeds are a particular problem. The crop should be planted on clean land. Some herbicides have soil residual characteristics that may negatively affect caraway seedlings.

Herbicide application records should be maintained. Consult the Saskatchewan Agriculture and Food (SAF) publication Guide to Crop Protection for more information on herbicides with soil residues.

Biennial caraway can tolerate some minor spring flooding in the second or third year. Under drought conditions, the plant roots will remain small. Seed yield will be minimal, but plant root development will continue. Seed will be produced in the year following drought, if precipitation is adequate. Very dry, cold winter conditions may increase winter kill or increase root damage and root crown diseases.

Some coriander and caraway crops have been severely affected by blossom blight (see Disease Control) which has occurred most commonly when cool, wet conditions prevail at the time of flowering.

Seeding

Biennial caraway is often seeded with a companion crop such as coriander, pea, flax, mustard, Rapa canola, or lentil. Coriander is the most commonly used companion crop for biennial caraway, as the herbicide options for the two crops are similar. Crops which compete well against weeds such as cereals should not be used as a companion crop. To reduce competition to the caraway, the seeding rate of the companion crop (other than coriander) should be reduced by approximately one-half.

Seed germination tests are important, as seed viability is a consideration especially if the seed is more than two years old. Germination and emergence of caraway may take up to three weeks, as the seeds need to mature in the soil for a short period after planting. A firm, moist and warm seedbed is required to enhance germination and speed plant emergence. Bridging of the seed in the seeder box can be a problem. Caraway and the companion crop seed should not be mixed in the same seed box, as this will cause flow rate problems due to the different seed densities.

The recommended seeding rate for biennial caraway is 13 kg/ha (12 lb./a.). The recommended seeding rate for annual caraway is 18 kg/ha (16 lb./ac.). The recommended seeding depth for caraway is two to four cm (¾ -1½ in.).

Caraway can be surface seeded using a granular applicator or a grass seeder followed by harrows, provided that a firm, moist seedbed is achieved. The seeding rate should be increased 50 per cent with surface seeding.

The suggested seeding date for annual caraway in Saskatchewan is late April to early May. For biennial caraway, early planting is recommended, but not critical. Seedlings have some tolerance to a late spring frost.

Fertilization

Caraway fertility trials have not been completed in western Canada. Fertility trials from other countries indicate that caraway requires nutrient levels similar to cereals and oilseeds. Soil testing prior to seeding will provide a good assessment of soil nutrient levels for the caraway and companion crops.

Because caraway is usually seeded with a companion crop, the fertilizer program requires careful planning. Enough fertilizer should be applied in the first year for both the companion crop and the caraway. If too little fertilizer is applied, the more competitive companion crop will use most of it, resulting in poor caraway development. Pay particular attention to phosphorus and potassium levels. An inadequate supply of these nutrients may increase winter kill. Excessive nitrogen in the first year can hinder hardening of the crop in the fall and can result in problems with over winter survival.

Nutrients such as nitrogen and sulphate-sulphur will move into the soil with rain. Therefore, the nitrogen and sulphur needed by the biennial caraway in the second year can be top-dressed in late fall or early spring. When surface application is the only placement option, urea-containing fertilizer (46-0-0 or 28-0-0) may be treated with a urease inhibitor prior to use in order to reduce ammonia volatilization losses. The urease inhibitor (AGROTAIN ®) will prevent the release of ammonia gas from the urea for a period of approximately two weeks, giving an opportunity for the urea to be moved into the soil by rainfall (see the product label for application rates and times of inhibition.) Liquid N (28-0-0) can also be injected with a spoke-wheel applicator, dribble banded or disc banded. Care must be taken with disc banders, as under certain soil moisture conditions, damage to a large number of plants can occur through tillage. A slow ground speed is recommended when using a disc bander in established caraway. Disc and coulter use for late fall application may lead to increased winter injury and open the soil to drying.

Phosphorus and potassium are much less mobile, and phosphorus is more readily fixed by the soil if it is not applied in a band. Accordingly, phosphorus and potassium fertilizer rates must be doubled or tripled if surface applied. If injection equipment cannot be accessed for use in the second year, producers may wish to band enough phosphorus and potassium for both years, prior to seeding. This may mean applying more than twice the normal annual phosphorus requirement due to consumption by the first year caraway and companion crop.

The maximum safe rate of fertilizer applied with the seed of caraway under Saskatchewan conditions has not been studied. It is recommended that seed-placed fertilizer not exceed 22 kg/ha (20 lb./ac.) P 2O 5 with 2.5 cm (1 in.) spread and 15-17.5 cm (6-7 in.) row spacing, under good to excellent soil moisture conditions. Higher rates of phosphate, plus any other nutrients needed to correct deficiencies based on a soil test, must be side or mid-row banded. There is no evidence of seed oil content or composition being influenced by fertility. For more information on fertilizers and their application, refer to the SAF publications dealing with fertilization.

Weed Control

Caraway may take up to three weeks to emerge, and is a poor competitor against weeds until the crop is well established. It is very difficult to control perennial broadleaf weeds such as Canada thistle or sow thistle in caraway. These weeds should be controlled in the year prior to planting caraway. Perennial weed control can become an increasing problem in the second and third year of the caraway stand. Severe weed competition can occur unless the crop is grown on clean land. The use of a companion crop may help suppress weed development during the first growing season of biennial caraway.

EDGE ® herbicide is registered in caraway for pre-emerge control of some annual grassy and broadleaf weeds. POAST ® herbicide is registered in caraway for post-emergent control of annual grassy weeds. Linuron herbicide is registered in caraway for post-emergent control of annual broadleaf weeds.

Care must be taken to ensure these herbicides are registered for use in the companion crop as well. Many producers use a pre-emergent burn-off application of glyphosate to control grassy and broadleaf weeds. Care must be taken to insure the application takes place before emergence of either the caraway or the companion crop. For more information follow the product label or consult the SAF publication Guide to Crop Protection.

Insect Control

Grasshoppers may be a pest, and grasshopper body parts in the seed sample can cause down-grading or rejection. Leaf hoppers may also be of importance as they transmit aster yellows disease. Attempts should be made to prevent the spread of leaf hoppers into the caraway crop.

DIPEL ® 2X DF insecticide is registered for use on herb and spice crops including caraway. Check the product label for pests controlled.

Disease Control

Crop rotations which provide a break from members of the carrot family for three years will help prevent the build up of plant diseases. Root diseases, such as damping off and root rot, can attack caraway seedlings. Symptoms of these infections include yellowing and death of newly emerged seedlings. MAXIM ® 480 FS seed treatment fungicide is registered for use on caraway.

Root diseases can also attack biennial caraway in its second and third year. Symptoms include slow growth and stunted development of the plant, premature yellowing and wilting, and poor seed set. Injury to the over wintering root caused by lack of snow cover, very dry conditions, or herbicide injury in the fall or early spring may increase the chance of infection by these root diseases.

Excessively wet soil conditions during the growing season can lead to *Fusarium* crown rot in established caraway. Symptoms include yellowing and death of the oldest leaves, and a softening of affected roots. A return to drier soil conditions often reduces the severity of this disease problem.

Caraway is susceptible to blossom blight caused an *Ascochyta* species. *Ascochyta* sp. will also cause blight on coriander. Additional fungal species that can cause blossom blight on both crops are: *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and *Sclerotinia sclerotiorum.* Persistent wet conditions during flowering increase the severity and rate of spread of blight. As flowers emerge, they turn brown and black, while the rest of the plant appears normal.

Flowers continue to die as they emerge and severely infected fields produce very little seed. Research is under way to determine the most suitable foliar fungicides and use patterns for prevention and control of the disease. The disease is both seed and residue-borne, so producers are advised to use the best seed available and maintain crop rotations which see coriander or caraway planted no more frequently than once in four years. For more information about blossom blight of caraway, see the SAF publication Blight Disease of Coriander and Caraway on the SAF Website.

Figure 3. *Aster yellows disease in caraway.*

Aster yellows is a virus-like plant disease common to many crops including caraway. Aster yellows is spread by leaf hoppers as they move from infected to healthy plants. Symptoms often appear at flowering time. Infected stems and flowering parts become malformed, turn yellow. Infected plants will not set seed (Figure 3.) No crop protection products are registered for control of aster yellows in caraway. In biennial caraway, the disease may over winter in the root, causing infected plants to die the following spring. Attempts should be made to remove infected plants, as this will slow the spread of disease. For more information on aster yellows and the aster leafhopper, see the SAF publication Aster Yellows on the SAF website.

Phoma blight is a seed-borne disease which can infect the stems, leaves, and flowers of caraway. Infestations at the flowering stage of the crop can result in no seed set. Later symptoms include grey to black, small raised lesions over the stems, and umbels (seed-bearing structures.) Seed from Phoma blight infected plants should not be used for planting. Phoma blight is much more destructive on dill than on caraway.

Harvesting

In the year of establishment, the companion crop should be cut as high as possible to allow maximum height of the remaining caraway crop. Biennial caraway is often ready to harvest in early August of the seed-producing year. Swath caraway when approximately 75 per cent of the seeds have turned dark brown. Delayed swathing increases the risk of seed shattering, while swathing too early can result in poor oil content and quality. Swathing allows for more even maturity of crop and drying of weed material. Swathing should be done in the morning or under damp conditions to reduce shattering. A swath roller may be used to reduce wind damage. Straight cutting caraway can be successful in some conditions, but may lead to excessive shattering losses. Caraway threshes very easily. Care should be taken when adjusting the combine to keep seed loss to a minimum, and prevent damage to the seed. When adjusting the combine, start with cylinder/rotor speed and concave clearance settings similar to those used for wheat. Caraway can be combined when the seed has turned brown and is at approximately 15 per cent moisture. Seed should be dried to a moisture content of 10 per cent or less. Aeration should be used to reduce the moisture content and temperature of the stored seed to reduce the risk of spoilage.

A biennial caraway field may be harvested again in the third year, provided sufficient numbers of plants did not already produce seed (and die), and weed populations are manageable. The decision to retain the stand can be deferred until stand health and weed infestation are evaluated early in the third growing season.

Storage

The microwave oven technique can be used to determine the moisture content of seed samples. Weigh 100 g of seed and place in microwave for 30 second intervals. Weigh the seeds between each interval. Repeat until the seed weight becomes constant after three intervals.

$$\text{Per cent seed moisture content} = \frac{\text{100 g - weight of seed after drying (g)} \times 100}{\text{weight of seed after drying (g)}}$$

Caraway seed must cure during storage. Natural air drying (aeration) is necessary for curing. Caraway oil is very volatile and hot air drying should be avoided if possible. Avoid concentrations of green foreign material, such as weed seeds, in the bin. An area with a high density of the green material can prevent uniform airflow during aeration and increased spoilage can occur. Green material should be cleaned from the sample as soon as possible. The sample must be free of foreign material at the time of sale. Caraway contains volatile oil which is lost over time from the seed into the air. This leads to a reduction in the quality of the product.

Processing and Grading

Caraway should be cleaned to the standards set by the American Spice Trade Association. A high percentage of dockage is often cleaned out during processing. Dockage levels of 15-20 per cent are common.

Caraway is graded by the buyer according to its aroma and appearance. Buyers prefer a dark brown colour with at least 99.7 per cent pure seed. Caraway seeds are curved, and tapered at each end with five pale ridges. The colour of the valley between each ridge should be dark brown.

Marketing

Canadian exports of caraway have ranged from 1,600-3,800 tonnes from 1997-2004, with the United States and the Netherlands as the main markets. The SAF publication Saskatchewan Special Crop Marketing Company Synopsis provides an annually updated list of companies that buy and sell caraway. Saskatchewan farm prices for cleaned caraway have ranged from $680-$1,550 per tonne (30-70¢ per pound) in recent years.

Economics of Production

The SAF publication Crop Planning Guide – Specialty Crops provides annually updated estimates of the expected costs and returns of biennial caraway production.

Additional Information

Saskatchewan Herb and Spice Association
The Grower's Guide to Herbs and Spices - (306) 242-8422
Agriculture Knowledge Centre Toll Free at 1-866-457-2377
Saskatchewan Agriculture and Food Website:

- Blight Disease of Coriander and Caraway
- Aster Yellows
- Saskatchewan Special Crop Marketing Company Synopsis
- Crop Planning Guide - Specialty Crops
- Guide to Crop Protection
- Guidelines for Safe Rates of Fertilizer Applied with the Seed

Alberta Agriculture, Food and Rural Development - Yellows Diseases of Echinacea, Monarda and Caraway

University of Saskatchewan - Diseases of Field Crops in Canada - University Extension Press 1-306-966-5565

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